and the motions are greater on the polar side of the cyclone, and on this side new portions of the atmosphere are continually drawn into the movement, since on this side $n \sin \phi$ is increasing steadily, while on the equatorial side the motion ceases by reason of the frictional resistance and inertia of the air. Thus the center of the cyclone is continually being formed anew during the progress toward higher latitudes. At the same time the cyclones in the region of the trade winds follow the general movement of the atmosphere, in these latitudes from east to west. From the resultants of the two constant forces, the polar tendency of the cyclones and the influence of the prevailing movement of the atmosphere, there result the parabolic paths of the cyclones, or their recurving when they pass from the trade winds into the region of the west winds.

The influence that a prevailing general current of air exerts upon the progress of a whirlwind that has entered into it evidently consists in this, that the masses of air drawn into the whirlwind have to follow two impulses: one, that which is due to the whirl, and the other, that which is due to their original movements. Therefore, in the region of trade winds and on the northwest side of a whirl, the motions are most accelerated, but on the opposite side are most retarded, and thereby the whirl must receive a tendency to progress toward the northwest. I believe that in its principal feature this agrees also with Lommel's theory of the recurving of the paths of cyclones on their leaving the trade wind region.

* * * * * * *

It would certainly be of the highest interest to know the distribution of temperature in the trade-wind region during a cyclone, for this would afford an important test of our storm theories. I believe, however, that students will find fewer difficulties in my presentation of the influence of a general atmospheric current upon a cyclone entering therein than in Lommel's. I do not think that everything is explained by this and by Ferrel's "polar tendency," but certainly both views should be taken into consideration.

But the buoyancy due to evolution of latent heat is only a part of the force at work. The moment a haze or cloud is formed in the presence of sunshine, the radiant solar heat is absorbed by it. All the heat that should strike the ground does its work at the upper surface of the cloud. The cloudy particles are evaporated, the outer layer of the cloud is warmed, and the cloud as a whole receives a great addition to its buoyancy. One may easily observe the illuminated side of a cloud rising while the shaded side is often falling. The indraft toward a storm region is thus greatly stimulated, and the storm increases in intensity. The barometer does not fall by virtue of solar heat, but by virtue of the increase in the movements of the air. The heat which first warms the cloud, just as it would otherwise warm the air at the ground, does not generally long remain manifest as heat to the thermometer; it becomes latent and maintains in the air a larger amount of moisture than would otherwise be present. This moist air is less dense than dry air and, therefore, more buoyant. Consequently, the ascending masses of air in the atmosphere may have the same temperature as, or be even colder than, adjacent descending masses of comparatively drier air. Either heat or moisture may suffice to make the air buoyant.

In ancient times, Dove spoke of the storms of the North Temperate Zone as occurring between two great currents of air, the northerly, or polar, and the southerly, or equatorial current, and many writers, rather prematurely, taught that great storms were generated in the region between these currents. To this idea two objections were made, namely, that on the one hand the polar and equatorial currents were too far apart and too feeble to have any such interaction on each other, and generate such violent whirls. On the other hand, if this were the sole cause of the hurricane, the latter would soon die away by reason of the resistances to the motion of the wind, and some regenerating process must be discovered in order to explain the generally steady increase in the intensity of such hurricanes up to the maximum before they begin to die away. After many years of discussion on these points it seems now to be generally admitted that a hurricane may begin in the space between opposing currents from the north and south quite as easily as in a region where buoyant air is rising and cloud and rain being formed, because there is a slight diminution of pressure in the space between such opposing currents sliding past each other, a diminution sufficient to induce a slight indraft and the formation of a gentle whirl. As to the maintaining power, however, it still appears likely that the principal source for this must be found in the condensation of moisture, the evolution of latent heat, and the interception of sunshine by the cloud. But we must add to these the further consideration that if the air to the northward is abnormally cold or dry, or that to the southward abnormally warm and moist, then the centrifugal force of the earth's rotation will drive the northerly air toward the equator, while the lighter air, by its buoyancy, is driven northward. Just as centrifugal force acts in separating cream from milk in the separator used in the dairy, while gravity separates the cream from the milk by a slower process in the old-fashioned dairies, so in the earth's atmosphere the heavy air is drawn to the ground by gravity or driven to the equator by centrifugal force, while the lighter air is pushed upward, or pushed northward, respectively. The general interchange of air between the polar and equatorial regions is due to differences of temperature, moisture, centrifugal force, and gravity, and is known as the general circulation of the atmosphere. We may therefore say that a whirl, when once started, developes into a hurricane under the combined favorable action of three forces; namely, the general circulation of the atmosphere, the absorption of solar heat by its own clouds, and the formation of cloud and rain with evolution of latent heat by its own internal currents and by the moisture of the air drawn into it from without. The relative importance of these three depends upon latitude, and must vary from storm to storm, and from day to day.—*C. A.*

A LEGAL DECISION AS TO DAMAGE BY LIGHTNING AND WIND.

In a periodical published by the University of Dijon we find an interesting decision by the civil tribunal of that city, relative to responsibility for damage done by lightning and wind. A few years ago we published a decision of the United States Circuit Court of Appeals (MONTHLY WEATHER REVIEW for December, 1900, p. 550) to the effect that forecasts of local rain have not yet attained such commanding respect by reason of their accuracy as to justify us in holding shippers guilty of culpable negligence if they do not provide against damage against heavy rains when light local showers are predicted. "The case of local rains is different from that of storms of great violence, whose existence, course, and time of arrival are publicly announced by signals which the master of a vessel is bound to observe."

With regard to the case on trial before the court at Dijon, the record shows that on June 30, 1901, at about 6 p. m., after a day of exceptional thunderstorms, an extremely violent wind occurred, producing great destruction. Besides the destruction due to the wind, many cases were found in which the damage was undoubtedly due to lightning. Public opinion and the local press attributed everything to the passage of a tornado. The work of destruction was accomplished in a few moments, and was followed by a heavy fall of hail over a large area, after which occurred an exceptionally heavy rain. The administration of the docks of Burgogne attributed a certain damage to lightning, and demanded that the repairs should be made by the nine companies in which they were insured; but, on the contrary, the insurance companies maintained that the disaster was equally attributable to the wind, and that, according to their policies, they did not insure in any manner against damage done by "hurricanes or cyclones, tornadoes, or any other meteorological or electrical phenomenon, except thunder and lightning."

In the trial before the judges, the facts of the disaster, the wind, and the lightning, were abundantly established. Then came a large mass of testimony relative to phenomena observed in Europe and America in connection with thunderstorms and tornadoes. Written or printed documents were

presented from about twenty meteorologists, including Profs. Alexander G. McAdie and Alfred J. Henry, of the Weather Bureau. Considerable time was given to the study of analogous cases of destruction by other tornadoes, such as that of Monville, August 19, 1845; St. Claude, August 19, 1890, and an elaborate study was made of the destruction in the present case, Dijon, June 30, 1901, most of which was evidently due to wind. After three days of pleading, the civil tribunal of Dijon finally rendered the following judgment on the 1st of July, substantially in accord with the opinion of two of the three experts: namely, Galliot, engineer-in-chief of bridges and roads; Pigeon, professor in the faculty of sciences at the University of Dijon; and Julien, civil engineer in Paris.

Notwithstanding the uncertainty of the experts, who have been unable to determine with exactness the amount of destruction due to lightning, on the one hand, and that due solely to the violence of the wind, on the other hand, it is, nevertheless, possible for the Court to pronounce the opinion that it is certain, according to the testimony of the experts, that the lightning and the wind acted almost simultaneously; that it is also certain that if the lightning, striking the building, M, and the shed, N, had not produced in these two structures a weak point, as is shown by the partial destruction of the boards and framework, that the wind would not have had force enough to demolish these two buildings, as was done; that the proof of this fact is also shown by that other testimony that the building, M, and the shed, N, are the only ones injured in the neighborhood of the docks. Other buildings, more or less important and of construction more or less unsubstantial, have suffered no damage, except, perhaps, some tiling displaced, such as the shed at the right of the principal entrance, on the boulevarde Voltaire, and the small administration building just opposite the entrance gate, which were not touched. It must, therefore, be concluded that the lightning stroke and the violence of the wind, by their combined action, had an equal part in the disaster, from which it follows that the responsibility for the disaster should be attributed one-half to the lightning stroke and one-half to the violence of the hurricane.

* * * Considering that the insurance companies have stipulated, in the general conditions printed in their policies, that the insurance covers only damage by fire resulting from lightning, but that, in consideration of a special premium, they are accountable for damages other than those by fire resulting from the stroke or explosion of lightning (the insurance against lightning not including in any case the damage caused by hurricanes, cyclones, tornadoes, or any other meteorological or electrical phenomenon other than thunder or lightning):

Considering, nevertheless, that, by a manuscript clause which is found in all the policies, the company gratuitously makes payment for damage that the stroke or explosion of the lightning, when duly attested, did or could have done to objects insured by the present policy, even when fire does not result:

Considering that it results with certainty from the stipulations above that the companies are responsible for damage other than fire directly due to lightning stroke:

Considering that it has been shown that the cause of the damage occasioned to the buildings and merchandise of the docks was due by one-half to the lightning stroke; that it is, therefore, this part which should be borne by the insurance companies and divided among them according to the proportions stated in their contracts.

* * * For these reasons,

The Court, after deliberating in accordance with the law,

Declares that the damages caused June 30, 1901, both to the buildings M and N of the Society of Docks and to the merchandise and contents, are due one-half to the lightning stroke and the other half to the violence of the wind;

Declares that one-half of the damage thus caused should be borne by the insurance companies, according to the proportions stated in their insurance policies, and with interest from the day of demand.

At the conclusion of this judgment, the two parties came together and adjusted this matter.—*C. A.*

WEATHER BUREAU MEN AS INSTRUCTORS.

Mr. H. W. Grasse, Assistant Observer, Moorhead, Minn., on July 19, addressed a class from the summer school, explaining the instruments and methods of the Weather Bureau. The summer school is composed chiefly of teachers from the surrounding country.

Mr. H. W. Richardson, Local Forecaster, Duluth, Minn., lectured at that place on July 27, before the teachers attending the summer school, taking as his subject, The Weather Bureau.

Mr. C. W. Strong, Section Director, Oklahoma, Okla., has been appointed on the faculty of Epworth University as instructor in meteorology, Mr. Strong says: "The courses connected with the University are elective, and can be taken up by the students at any time, and in any year's work. The student can take up our particular work and carry it to completion at any time during the four years' period of instruction."

The State College of Kentucky has decided to establish a course of instruction in meteorology, which will be given for the first time during the coming school year. Mr. R. H. Dean, Observer at Lexington, Ky., has been appointed instructor in meteorology, and has been requested to formulate an outline for the course of study. It is probable that the course will be given in connection with the course in agriculture.

Mr. J. W. Bauer, Section Director, Columbia, S. C., on August 9, addressed an audience of about two hundred planters at the annual meeting of the Darlington Agricultural Society. The address was devoted principally to the work of the Weather Bureau as related to agriculture, including the forecast and warning services, and the Climate and Crop Service.

Mr. Merton L. Fuller, Assistant Observer, Springfield, Ill., delivered, during July and August, eight addresses before three of the teachers' institutes of Iowa, having a total attendance of over five hundred teachers, and comprising nearly the entire teaching force of Buena Vista, Calhoun, and Wright counties. The addresses were illustrated by blackboard work, and by twenty specially prepared charts and diagrams. The general circulation of the atmosphere was briefly reviewed; the storms of both tropical and temperate latitudes were described; and the weather of Iowa, as affected by general atmospheric conditions, was discussed in some detail. Thunderstorms and tornadoes formed the subject of one of the lectures and another was devoted to weather forecasting, with a description of the work of the Bureau, and some consideration of common "weather signs" and "long-range" forecasts.

Mr. Richard H. Sullivan, Observer, Grand Junction, Colo., lectured on August 4, under the auspices of the Western Colorado Academy of Sciences, on "Practical Meteorology." The lecture was illustrated by thirty slides, many of which were prepared by the lecturer from text books and the office climatic charts.

THE HELWAN AND ABBASSIA OBSERVATORIES.

The Survey Department of the Public Works Ministry of Egypt has issued the following notice:

On January 1, 1904, the Observatory, which has hitherto been situated at Abbassia, on the north side of Cairo, was transferred to its new site at Helwan, about 22 kilometers south of Cairo. The buildings are on the limestone rock, which here forms the surface of the desert, and have an open view over the desert to the northeast and south, while on the west is the Nile Valley, the nearest cultivation being 3 kilometers distant.

At present the main building is occupied, and the meteorological equipment, with complete self-registering apparatus, is installed there; also the arrangement for furnishing the noon time-signal, which drops the time balls at Port Said and Alexandria. There is, besides, a new transit house and an equatorial house. The house for magnetic self-registering instruments is not yet completed.

The position of the transit pillar is: Latitude 29° 51′ 33.5″ north, longitude 31° 20′ 30.2″ east of Greenwich. This latter value depends upon the "Venus station," on the Mokattam Hills at Cairo, being longitude 31° 16′ 33.6′ east of Greenwich.

The altitude of the cistern of the barometer above mean sea level at Alexandria is 115.6 meters.

The Abbassia Observatory was established in 1868. It was reorganized in 1900 and equipped with automatic apparatus whose records replaced, to a large extent, the previous tri-